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*Published in:*  
European Journal of Developmental Psychology

*Publication date:*  
2008

*Document Version*  
Publisher's PDF, also known as Version of record

[Link to publication in Tilburg University Research Portal](#)

*Citation for published version (APA):*  
Shebani, M. F. A., van de Vijver, F. J. R., & Poortinga, Y. H. (2008). Memory development in Libyan and Dutch school children. *European Journal of Developmental Psychology*, 5(4), 419-438.

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Publisher: Psychology Press  
Informa Ltd Registered in England and Wales Registered Number: 1072954  
Registered office: Mortimer House, 37-41 Mortimer Street, London W1T 3JH, UK



## European Journal of Developmental Psychology

Publication details, including instructions for authors and subscription information:  
<http://www.informaworld.com/smpp/title~content=t713684600>

### Memory development in Libyan and Dutch school children

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First Published: July 2008

To cite this Article: Shebani, Mustafa F. A., van de Vijver, Fons J. R. and Poortinga, Ype H. (2008) 'Memory development in Libyan and Dutch school children', *European Journal of Developmental Psychology*, 5:4, 419 — 438

To link to this article: DOI: 10.1080/17405620701343204

URL: <http://dx.doi.org/10.1080/17405620701343204>

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## Memory development in Libyan and Dutch school children

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Cross-cultural similarities and differences in memory were examined in two studies with Libyan and Dutch school children of two different grades. The first study analysed effects of word length and pronunciation speed on recall. Baddeley's phonological loop hypothesis could fully account for the somewhat larger digit span of the Dutch children. The second study investigated effects of rehearsal training on recall. Experimental groups showed a higher performance increase after training than did control groups; Libyan children with the same pretest scores as Dutch children showed higher posttest scores, which could be a consequence of sample differences in age or test-wiseness. The studies demonstrated that current theories provide more precise explanations of cross-cultural differences in structural memory features than in control processes. Implications for instructional practice are discussed.

We examined developmental changes in two components of memory functioning with school children of two countries, Libya and The Netherlands. In their model of good information processing, Schneider and Pressley (1997) argued that multiple aspects of memory need to be addressed to comprehend memory functioning. The two aspects selected for this project, memory span and rehearsal, have been studied extensively and are considered relevant for education. They vary in the degree to which they

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represent “hardware and software” aspects of memory (e.g., Schneider & Pressley, 1997). We demonstrate how cultural factors differ in their effects on these aspects.

An important distinction in theorizing on memory is between structural features and control processes. Structural features include a short-term memory store, a long-term memory, and forgetting (e.g., Atkinson & Shiffrin, 1968; Schneider & Pressley, 1997). Control processes are strategies that help in the encoding and retention of information and in retrieval; they include rehearsal and grouping of items that belong together. There is debate about whether structural features change from childhood to adulthood, but control processes, such as rehearsal and clustering of information to be remembered, definitely increase with age. The development of control processes has been found to begin as early as 3 years of age and to continue until about the age of 13 (Wellman, Ritter, & Flavell, 1975).

Early cross-cultural research has shown that structural features, such as the size of the short-term memory store and the rate of forgetting, are largely similar across cultures (Wagner, 1981). However, there are substantial differences in the use of control processes. For example, Cole, Gay, Glick, and Sharp (1971) found large differences between Kpelle participants of different ages and 11-year-old American children on free recall tasks in which lists of clusterable and non-clusterable words or objects were presented. The results suggested that the Kpelle participants did not spontaneously employ semantic organization strategies and verbal rehearsal.

Wagner (1974) presented drawings of animals and familiar objects on seven cards to samples in Mexico. A serial memory task was administered in which each of the seven cards was first shown and then placed face down. The respondent was shown a single “probe” card, and had to indicate its location in the array of face-down cards. The results provide a serial position curve, in which there is a recency effect as well as a primacy effect. There were differences in primacy recall reflecting a greater use of rehearsal associated with age and schooling.

Later on, Wagner (1978, 1981) pointed to an important problem in his study, in that the effects of schooling and cultural context were confounded. Participants with school experience came from the capital of the Yucatan province in Mexico, whereas the illiterate samples were recruited from rural areas. The two factors of schooling and urbanization were separated in Wagner’s (1978) study in Morocco. Two main experiments were carried out with samples varying in age (6–9 years; 10–12 years; 13–16 years; and 17–22 years), in schooling (schooled vs. unschooled), and in environment (urban vs. rural). Both of the two latter factors had an effect on overall recall, with the urbanization effect especially apparent in the younger children. The effect of schooling was larger among the older children. The

number of years in school seemed to be important in producing a primacy effect. Schooling increased overall recall and older schooled children also showed better primacy recall than non-schooled children. Wagner interpreted this as evidence that rehearsal strategies are a product of schooling.

Results from several studies have supported the notion that Western-type schooling influences memory performance on tasks that have relevance for formal educational settings, such as lists of items that have to be memorized and later recalled (e.g., Rogoff, 1981; Scribner & Cole, 1981; Sharp, Cole, & Lave, 1979). The effect of control processes was also demonstrated in two studies by Kearins (1981, 1986). She presented Australian Aboriginal children and children of European descent with a visual-spatial task where objects arranged in rectangular grid were inspected and had to be placed back in the original position after having been put in disarray. The Aboriginal children, even when living in an urban environment, had on average a better performance. Initially, Kearins (1981) attributed this to a selection effect of the hunting-gathering mode of existence, which implies a high need for spatial orientation. In subsequent research, she showed that the difference in performance disappeared when the European children were trained to follow the memorizing strategy of the Aboriginal children (Kearins, 1986).

### The current project

We describe two studies with Libyan school children of two age groups, with reference data collected from a Western country, The Netherlands. Libyan children from the age of 6 or 7 years have to be enrolled at the (Western-type) primary schools for six years. A few years ago private preschools in big cities began to be established. These preschools, generally located in small buildings, are part of the public educational system of the country. They have a curriculum of three years, which emphasizes preparation for primary school with activities such as learning to read and write and basic arithmetic. The tuition and additional expenses are high; therefore, few children attend such institutions. Education in primary schools is compulsory for all children and almost all schools are similar in terms of pedagogy, curricula, and educational background of the teachers. Rote learning and recitation of poems, songs, and Suras of the Quran are common in everyday classroom activities. The educational level of mothers is typically limited to a few years of primary school, while the levels of literacy and education of the fathers tend to be somewhat higher. The rural and urban settings are known to differ somewhat in terms of availability of literacy in the ambient environment, such as the mass media, newspapers, books, and cinemas.

The contemporary educational system in Libya does not include Quranic schools, therefore attending such schools is not compulsory for children.

Only a small percentage of Libyan children at the formal school age attend such schools during summer vacation, and the attendants are mainly boys. The curriculum of Quranic schools varies across teachers to some extent, but usually includes the Arabic alphabet, and numerous verses of the Quran to be recited and memorized. Quranic schools also teach Islamic principles and ethics.

The current project served both a theoretical and a practical purpose. The theoretical aim was to enlarge our insights in cross-cultural differences and similarities with a set of memory studies that differ in terms of the nature of cultural mediation. The first study was on memory span and the influence of reading (or pronunciation) speed on recall; memory span is widely viewed as an important index of mental capacity. It refers to a structural feature of memory functioning for which a detailed theory is available about the cross-cultural differences to be expected. More specifically, we tested whether Baddeley's phonological loop hypothesis could account for cross-cultural differences in memory span. Any differences that possibly remain after correcting for cross-cultural differences in reading speed should be due to cultural bias (e.g., familiarity with the stimuli in a task and experience with testing). Support for the hypothesis provides important evidence that the cross-cultural differences in memory span in our study can be parsimoniously explained by referring to the presumably universal mechanism of reading speed. Generating and testing models of cross-cultural differences on the basis of specific cultural features is one of the main goals of cross-cultural psychology (Berry, Poortinga, Segall, & Dasen, 2002). The second study also attempted to link cross-cultural differences to universal, underlying mechanisms; the study addressed effects of rehearsal training on recall. Presumably, positive effects of training on recall are universal and should account for cross-cultural differences in the use of rehearsal strategies; any implicit or explicit training in rehearsal amounts to a form of cultural mediation.

The studies reported in this article were also meant to serve a practical purpose. An adequate comprehension of the relationship between schooling and memory performance can optimize instruction. An appreciation of what is identical and different in memory across cultures will help to design culture-informed school curricula.

## STUDY 1: MEMORY SPAN AND PRONUNCIATION SPEED

Short-term memory is characterized by a limited capacity for storing information and by rapid decay. Various models have been developed to explain these characteristics. For example, neo-Piagetian theories employ notions such as attentional capacity, mental space, and mental power (Case,

1987, 1992; Pascual-Leone, 1970). An extensively studied model originally published by Baddeley and Hitch (1974; see also Baddeley, 1997) postulated a triple system. It consists of a central executive, which is a control system, and two slave systems, the visuo-spatial sketchpad for visual information and the articulatory or phonological loop for verbal information. The phonological loop is the most studied part of the system; its role is to hold and manipulate verbal material. Two components are distinguished: a phonological store and rehearsal. The latter helps to maintain stored items as well as to recode verbal material presented visually. The limits of the phonological loop are not primarily defined in terms of the number of elements it can contain, but in terms of the amount of time before decay sets in. The loop contains as much information as can be rehearsed in approximately 1.5 to 2 seconds. Baddeley's model involves both structural features (e.g., the existence of a phonological loop and of a storage capacity that is limited by rehearsal speed) and control processes (e.g., active rehearsing in a memory task). However, in tests of the model there is an emphasis on structural features (which is shared in the current study).

Memory span is defined as the longest sequence of items that can be recalled in correct order immediately following presentation. In adults, span is about seven items for a random sequence of letters, digits or words (Miller, 1956). It has been known for a long time that in children memory span improves with age (cf. Henry & Millar, 1993). The two factors that have been implicated most often to explain differences in memory span are familiarity of the stimulus materials and the use of control processes such as rehearsal and organization of the stimuli (e.g., Chi, 1978; Nicholson, 1981; Ornstein, Naus, & Liberty, 1975). The cross-cultural findings mentioned in the introduction clearly hinge on these two factors. However, evidence has accumulated that individual differences in memory span across different materials, ages, and languages can be accounted for largely on the basis of differences in the rate at which items can be pronounced (Schweickert, 1993).

Hulme, Thomson, Muir, and Lawrence (1984; see also Nicholson, 1981) examined the effect of word duration (i.e., the time it takes to pronounce a word) on memory span in children of different ages. The same linear function relating recall to speech rate (assessed by the speed of repeating words) fitted the results of participants ranging in age from 4 years old to adulthood. In a similar study, Hulme and Tordoff (1989) examined the effect of word length and acoustic similarity on speech rate and serial recall in children ranging in age from 4 to 10 years. Children of different ages showed a word-length effect and there was an increase in recall with age. In the case of words of different length, differences in recall were closely related to the rate at which they could be spoken. Other researchers have reported similar

results (e.g., Hitch, Halliday, Dodd, & Littler, 1989a; Hitch, Halliday, & Littler, 1989b; Hitch, Halliday, Schaafstal, & Heffernan, 1991).

Memory span as a function of word length has been assessed in a number of cross-cultural studies (e.g., Chincotta & Hoosain, 1995; Ellis & Hennelly, 1980; Hoosain & Salili, 1987; Lau & Hoosain, 1999; Zhang & Simon, 1985). For example, Stigler, Lee, and Stevenson (1986) compared children from Japan, Taiwan, and the United States in kindergarten, first grade, and fifth grade on a digit-span test. Japanese and American score distributions were fairly similar, but differed substantially from the distribution of the Chinese children. The mean digit span of the Chinese, Japanese, and American children in kindergarten were 5.9, 4.1, and 4.6, respectively; 6.4, 4.4, and 5.1 for the first graders; and 6.9, 5.5, and 5.9 for the fifth graders. The explanation for these findings is that there are differences in the time required to pronounce number words in the languages involved. Reading time was measured as the time elapsed from the child beginning to pronounce the first of a number of words to the completion of the last word. Articulation time for the Chinese averaged 406 ms per digit, while in English the average was 527 ms.

Of interest is a study by Naveh-Benjamin and Ayres (1986) because it involved speakers of not less than four languages, namely English, Spanish, Arabic, and Hebrew. All were students at a Hebrew-medium university. They were tested on digit span, speeded digit reading and story reading speed. The memory span for English, Hebrew, Spanish, and Arabic was 7.2, 6.5, 6.4 and 5.8 digits respectively, and the speeded digit reading time was 256, 309, 287, and 370 ms per digit. Thus, high span corresponded to fast reading of digits. The story reading time at normal pace followed the same order, with the English reading clearly faster, the Arabic clearly slower and the Spanish and Hebrew close together in the middle.

The present study assessed memory span in Libyan school children of two different age groups, as well as the effects of reading speed on span, using data from The Netherlands as a comparison standard. Differences in performance were expected for the two languages, since numerals in Arabic tend to be longer (in pronunciation time). Considering memory capacity as culturally invariant, we hypothesized that any differences in memory span scores could be explained in terms of differences in word length between Arabic and Dutch.

## Method

### *Participants*

The Libyan sample consisted of 64 third- and fifth-grade children from two elementary schools in Garian, a semi-urban area of the western



part of Libya. A total of 14 boys and 18 girls of 8 and 9 years of age and 16 boys and 16 girls of 10 years of age were recruited from each school. The children spoke only their native language, which is Arabic. The children came from middle-class families. The Dutch sample consisted of 40 children from a semi-urban area close to Tilburg, The Netherlands. They were recruited from the third and fifth grade of two elementary schools, 5 boys and 5 girls of 8 years of age and 5 boys and 5 girls of 10 years of age from each school. All children had been born in the Netherlands, and were native speakers of the Dutch language.

Selecting the age of the participants was not straightforward, as it was impossible to match on both chronological and educational age in a comparison of Libyan and Dutch children. The age for any grade is on average one year higher in Libya than in the Netherlands. Also, enrolment rates of pre-primary schooling are above 95% in the Netherlands and below 10% in Libya (UNESCO Institute for Statistics, 2005). Finally, Libyan primary-school children have been less exposed to educational and psychological testing than Dutch children. No precise matching on any independent variable was attempted, as this may easily lead to a mismatch on some other variable in culture-comparative research (e.g., Poortinga, 1989; Van de Vijver & Leung, 1997). In the present instance, matching on calendar age would have led to a mismatch on school age, and vice versa. The ages and grades of the Dutch children were chosen in such a way that the level of performance would be approximately similar to that of the Libyan children. Cross-cultural matching on performance levels is used in the methodological literature to create conditions of psychometric comparability of individuals across cultures (see, for example, the literature on differential item functioning; Van de Vijver & Leung, 1997).

### *Materials and procedures*

There were two memory-span tests, one for digits and one for words. The word-span test consisted of two subtests in both languages, one with shorter and one with longer words. For speed pronunciation there were matching subtests.

*Digit span.* Lists were composed from the set of integers from 1 to 9. The lists ranged in length from 2 to 8 digits. The Arabic language has short and long forms of each digit. The short form, which is most frequently used in everyday language, was used here (see Shebani, Van de Vijver, & Poortinga, 2005, for a study on the psychological implications of the difference). Selection was random but with restrictions; no digits were repeated in a trial;

no successive numbers (e.g., 2–3) followed each other; and sequences of numbers with phonological similarity were avoided. Digitized records of the stimuli spoken in each language by a native female teacher were used to prepare lists of trials.

Each child was tested individually, and answers were recorded on tape for later scoring. Six trials with a length of 3 or 4 digits were presented as training. Actual testing started with 2 digits; there were three trials at each list length. If the child failed on all three trials of a certain length, the test was terminated and the score was equal to the number of digits at the previous level. If only one of three trials was correct, the test was stopped and the score was the number of digits recalled correctly three times, plus a bonus of 0.5. With two out of three trials correct, the test was stopped and the score was the number of digits in these trials.

*Word span.* Two sets of 8 Arabic words and two sets of 8 Dutch words were assembled that had been evaluated for familiarity by Dutch and Libyan preparatory school teachers. The two sets in each language differed in word length as measured by number of syllables (i.e., 2 and 3 syllables for the Dutch words; 3 and 4 syllables for the Arabic words). Lists, varying in length from 2 to 8 words, were composed in the same way from digitized records as the lists of digits. The testing session was preceded by a session in which the child was asked to repeat each item several times to ensure that the words could be pronounced without difficulty. In the testing session the same procedure was followed as described for the digit-span tasks.

*Speeded digit pronunciation.* Articulation rate was defined as the number of items a participant could say in one second (items per second). The digit-pronunciation test consisted of eight pairs of digits typed in medium-size fonts, each pair on a separate sheet. The child was asked to repeat, aloud and as quickly as possible, a pair of digits and continue until told to stop. Each pair of digits was to be repeated ten times; the experimenter did the counting. It should be noted that once they had been read, the digits could be repeated from memory. The pronunciations of the children were recorded on audiotape and scored (in milliseconds) from a graphic representation of the vocal record.

*Speeded word pronunciation.* Pronunciation speed was defined as the number of words a child could say in one second. For these tasks the same words as used in the span test were grouped in pairs, resulting in 4 word pairs of short words and 4 long word pairs. The same administration procedures were followed as described for speeded digit pronunciation.

## Results

A multivariate analysis of covariance was carried out with culture, grade, and gender as independent variables, and the span score on the digits and short and long words as dependent variables; the pronunciation time of the latter three variables were the covariates (each dependent variable had its own covariate). In order to evaluate the impact of the covariates, effect sizes are reported before and after correction. Table 1 also presents the means and standard deviations on the span and speed tests, while the effect sizes and their significance are given in Table 2. The multivariate effect of culture was large and significant,  $\eta^2 = .24$ ,  $p < .01$  ( $\eta^2$  refers to the proportion of variance explained by the independent variable, culture in the present example; Cohen, 1992, has proposed .01, .06, and .14 as boundary values of small, medium, and large effects). As can be seen in Table 1, the Dutch children showed a higher performance. However, the country differences were no longer significant after correction for pronunciation speed,  $\eta^2 = .06$ , *ns*. So, differences in short-term digit span of these two countries can be fully accounted for by pronunciation speed differences. Age differences (with older children showing higher scores) were found for each memory test, but the effects were only significant for digits ( $\eta^2 = .12$ ,  $p < .01$ ) and long words ( $\eta^2 = .14$ ,  $p < .01$ ). These effect sizes became smaller but remained significant after correction ( $\eta^2 = .05$  and .08, respectively; both  $ps < .05$ ). Gender showed a significant effect only for digits ( $\eta^2 = .07$ ,  $p < .01$ ); girls showed a higher performance than boys. After correction the multivariate effect became significant, rising from .07 to .12. The effect for digits increased from .07 to .10 (both  $ps < .01$ ). Short words showed an increase in effect size from .01 (*ns*) to .05 ( $p < .05$ ). The increase of the gender differences after correction was mainly a consequence of the gender differences in

TABLE 1  
Means (and standard deviations) of memory span and pronunciation speed (number of digits/words per second) per age and country

Variable	Libyan		Dutch	
	Grade 3	Grade 5	Grade 3	Grade 5
<i>Span</i>				
Digits	3.53 (0.57)	3.81 (0.58)	4.28 (0.64)	4.80 (0.75)
Short words	3.36 (0.46)	3.50 (0.62)	3.65 (0.43)	3.88 (0.60)
Long words	3.14 (0.34)	3.42 (0.53)	3.30 (0.34)	3.78 (0.62)
<i>Pronunciation speed</i>				
Digits	1.30 (0.18)	1.57 (0.16)	3.01 (0.41)	3.27 (0.48)
Short words	1.48 (0.25)	1.81 (0.24)	2.03 (0.26)	2.18 (0.34)
Long words	1.31 (0.19)	1.59 (0.24)	1.53 (0.18)	1.78 (0.24)

TABLE 2

Analysis of covariance of memory span with pronunciation speed as covariate: Effect sizes before and after correction for the covariate

<i>Source</i>	<i>Variable</i>	$\eta^2$ <i>before</i>	$\eta^2$ <i>after</i>
Culture	(Multivariate)	.24**	.06
	Digits	.24**	.04
	Short words	.09**	.00
	Long words	.07**	.01
Age	(Multivariate)	.18**	.13**
	Digits	.12**	.05*
	Short words	.03	.00
	Long words	.14**	.08**
Gender	(Multivariate)	.07	.12**
	Digits	.07**	.10**
	Short words	.01	.05*
	Long words	.00	.01

*Note:* As no interaction component was significant, effect sizes are only reported for main effects. \* $p < .05$ ; \*\* $p < .01$ .

pronunciation speed: boys were faster readers than girls, but this difference was not found on the memory task. None of the interaction effects were significant.

## Discussion

This study addressed a presumably universal feature of human memory: the phonological loop. Cross-cultural differences in short-term memory span were assessed and the adequacy of the phonological loop model to account for these differences was tested. Using analysis of covariance, it was found that cross-cultural performance differences were no longer significant after correction for differences in pronunciation speed. Our findings confirm previous studies (e.g., Naveh-Benjamin & Ayres, 1986). Baddeley's phonological loop model could only partly account for the observed age differences. The model could not explain the small gender differences; on the contrary, the phonological loop model would have predicted larger gender differences in memory span than we observed. However, the cross-cultural differences in memory span could be accounted for entirely in terms of differences between Dutch and Arabic numerals in pronunciation speed. This explanation rules out broader (and fuzzier) cultural or educational factors (see general discussion). In summary, the phonological loop model successfully explained cross-cultural differences in memory performance, even though it was less successful in explaining age and (particularly) gender differences.

## STUDY 2: MEMORY SPAN AND REHEARSAL TRAINING

The second experiment addressed memory aspects, which are more under conscious control and are usually the consequence of a deliberately chosen strategy. Vocal or subvocal rehearsal of materials to be remembered is considered a suitable strategy of memorization in many memory tasks, both in school and in everyday life. Literature on the development of rehearsal strategies points to an increase of memory strategies (such as rehearsal) with age over the middle-childhood years (Schneider & Pressley, 1997). Flavell, Beach, and Chinsky (1966) described the development of rehearsal among children of 5, 7, and 9 years of age in a serial recall task with a 15-second delay between presentation and recall. Age-related increases in both the amount of rehearsal and levels of recall were found. Only very few children of the age of 5 years showed rehearsal strategies involving more than a single item; in contrast, most of the oldest children cumulatively rehearsed the list items. Flavell et al. concluded that verbal rehearsal serves as mediator in recall in children and that recall increases rehearsal.

Naus, Ornstein, and Aivano (1977) trained third graders to use three-item rehearsal sets. These children displayed the primacy effect typical for older children; in addition their recall was approximately at the level of grade-six children. At the same time, although training young children increases their levels of recall, age differences are usually not eliminated. Kunzinger (1985) reported a longitudinal study of overt rehearsal; 7-year-old children were presented with lists of words and tested for recall. They were tested again after two years. There was an increase in rehearsal set size with development (from 1.7 to 2.6 items). Guttentag, Ornstein, and Siemens (1987) observed a comparable increase in rehearsal set size of children between 8.5 and 9.5 years of age.

Motivational factors can play a role in cumulative rehearsal. Kunzinger and Witryol (1984) gave 7- and 8-year-old children sets of words to rehearse and remember. Some words were identified as 10-cent words. Children would receive this amount for each of these words they remembered. Other words were designated as 1-cent words, and this amount was given for each of these words they recalled. Children rehearsed the 10-cent words twice as much as the 1-cent words. This indicates that even fairly young children can be motivated to use a more active rehearsal strategy.

Training to increase speech rate has not shown positive results. For example, Hulme and Muir (1985) gave a short training to children aged 7 years to increase their speech rate. The results indicated a very small increase in speech rate and in recall. In a subsequent experiment, Hulme and Muir gave children an extensive training over five consecutive days. The extensive training of speech rate did not appear to produce any selective increase in recall scores.

With increases in age the application of mnemonic strategies seems to require less effort and to become increasingly routinized. Ornstein et al. (1975) indicate that with easy tasks second graders can execute an active rehearsal strategy quite effectively. In this experiment, second graders rehearsed aloud under a variety of different rehearsal conditions. The number of items varied in each rehearsal set. Compared with a baseline condition, the children benefited from an instruction to actively rehearse the items.

Scribner and Cole (1981) found effects of Quranic schooling on serial memory. However, these effects did not generalize to other memory and cognitive tests. In one of the few cross-cultural training studies, Carr, Kurtz, Schneider, Turner, and Borkowski (1989) taught German and American primary-school children to use an organizational strategy in a memory task. The American children used this strategy less often than the German children at baseline level and gained more from the training.

The main question addressed in the present study was whether training to use certain rehearsal strategies can improve both Libyan and Dutch children's memory span and can enable them to use such strategies more effectively. Libyan and Dutch school children at two ages were given training to implement rehearsal strategies in a memory span task. Since the Libyan school curriculum is based on the same principles as in West-European countries, we had no reason to anticipate culture-specific gain patterns. However, if initial differences in memory span were observed, training should help to reduce these, as children with lower scores, who presumably rehearse less, should profit more from training.

## Method

### *Participants*

The Libyan sample consisted of 64 children, 8 and 10 years old, half girls and half boys. They were selected from second and fourth grades in elementary schools located in the same region as described in Study 1. The Dutch sample consisted of 32 girls and 32 boys of 6- and 8-year-old children from first and third grades. They came from the same region as described in Study 1. In each of the two countries the children were assigned randomly to the non-training (control) condition and the training (experimental) condition.

Given the incompatibilities in matching criteria such as educational and chronological age, which were described before, we decided again to use matching on performance levels. A pilot study was conducted to determine the age for the younger group; it was the lowest age at which the tasks could be adequately administered. The older age group was chosen to be two years older; authors like Flavell et al. (1966) and Kingsley and Hagen (1969)

found an increase in spontaneous use of rehearsal over this age range. Pilot results led us to select 8-year-old children for the younger sample in Libya and 6-year-old children in the Netherlands.

### *Materials and procedure*

Two sets of Dutch words and two sets of Arabic words for pretest and posttest were selected from larger domains, namely fruits and animals. Lists were composed, varying in length from 3 to 7 words with three lists at each level. Words were not repeated in the same trial, and words at the end of the previous trial were not repeated at the beginning of the next trial, to prevent systematic patterns from entering the lists. Practice lists to be used in the training phase were separately derived from Libyan and Dutch textbooks; they did not overlap either with the pretest or the posttest lists.

The administration of the tasks was in three phases: (1) a pretest to determine the initial span; (2) training (only for experimental groups); and (3) a posttest to determine span. The same lists of words were used for the pretest and posttest. Half of the children received the fruit words test first and the other half the animal words. The pretest was a typical test of memory span. After familiarizing the child with the words and some practice trials, items were presented at the rate of 1 item every 2 seconds. This slow presentation rate was necessary to enable and facilitate rehearsal. The scoring procedure of Study 1 was used.

For the rehearsal training lists of unrelated words were used. During the course of training each child was seen individually three times, for approximately 15 minutes. The child was prompted to recite, quickly, groups of words during the standard presentation of lists and before recall. Training was started on the list length that the child had failed in the pretest of memory span. A list was divided into groups of words (2 and 1, 2 and 2, 3 and 2, depending on the span level that might have been obtained by a child on the pretest). Trials of a given length were practiced until the child correctly completed two trials out of three, using the training rehearsal strategy. The control group did not receive any instructions on how to remember or to rehearse the items. They were asked to repeat the items (without reference to any rehearsal strategy). The practice trials were on the span length that the child had failed on the pretest. The posttest was a replication of the pretest, except that children in the training condition were reminded to apply rehearsal.

## **Results**

The means, standard deviations and gains are presented in Table 3. Training effects were tested in an analysis of variance (ANOVA; repeated measures)

TABLE 3  
Means of rehearsal training for treatment, grade, and culture

<i>Culture</i>	<i>Grade 1, 2</i>		<i>Grade 3, 4</i>	
	<i>Experimental</i>	<i>Control</i>	<i>Experimental</i>	<i>Control</i>
Libyan				
Pretest	4.00	3.78	4.28	4.28
Posttest	4.63	4.16	5.41	4.69
Gain	0.63	0.38	1.13	0.41
Dutch				
Pretest	3.47	3.94	4.00	3.91
Posttest	4.35	4.12	4.44	4.26
Gain	0.88	0.18	0.44	0.35

with Training (experimental vs. control), Grade (lower vs. higher), and Culture (Libyan vs. Dutch) as between-subject factors, and Time of Administration (pre vs. post) as within-subject factor. We describe the between-subject effects first. Differences between grades ( $\eta^2 = .13$ ,  $p < .01$ ) were substantial and in the expected direction. The mean score of the Libyan children was 4.40, which was substantially higher than the mean of 4.06 of the Dutch children ( $\eta^2 = .12$ ,  $p < .01$ ). The training effect was also significant though much smaller,  $\eta^2 = .04$ ,  $p < .05$ ; participants in the experimental condition showed higher scores. The training by culture interaction was significant, though relatively small,  $\eta^2 = .03$ ,  $p < .05$ ; the difference between the experimental and control groups was .35 in Libya and .01 in The Netherlands. The interaction of grade and culture was also significant,  $\eta^2 = .03$ ,  $p < .05$ ; the grade difference in scores was larger in the Libyan group than in the Dutch group (.63 and .46, respectively). This finding is in line with other studies that have reported more gain in groups that were less familiar with testing (e.g., Van de Vijver, Daal, & Van Zonneveld, 1986).

The largest within-subject effect was the pretest–posttest difference,  $\eta^2 = .59$ ,  $p < .01$ ; the pretest average was 3.95 and the posttest average 4.50. The interaction of training group and time of administration was large and significant;  $\eta^2 = .19$ ,  $p < .01$ ; this interaction and the (smaller) main effect of training reflect the posttest gains in memory span of the experimental groups of on average .77 words and of .33 words for the control groups. Three more interaction components were significant. The first was the interaction of culture and time of administration,  $\eta^2 = .03$ ,  $p < .05$ ; the Libyan children gained more from training than did Dutch children. The second was the triple interaction of grade, culture, and time of administration,  $\eta^2 = .04$ ,  $p < .05$ ; the pretest–posttest difference in the lower grades were more or less similar in the two countries (about .50), while the differences in the higher



grade were larger than the lower grade differences in Libya (.77) and smaller in The Netherlands (.40). Finally, the quadruple interaction was significant,  $\eta^2 = .08$ ,  $p < .01$ ; differences in pretest–posttest changes between experimental and control samples were somewhat smaller in the lower grade in Libya than in The Netherlands while the opposite was found in the higher grade.

The overall picture of the gains after training is complicated due to the significance of interactions. Therefore, we carried out an additional analysis aimed at a cross-cultural comparison of the relationship between pretest and posttest scores. An ANOVA was carried out with three independent variables: Culture (2 levels), Treatment (2 levels: experimental vs. control) and Pretest Score Level. As can be seen in Figure 1, the latter variable was divided into three levels: 3 and 3.5; 4; 4.5 and 5 (the merging of score levels at both extremes was needed in order to avoid very small cell sizes). The posttest score was the dependent variable. The analysis yielded a significant effect of culture,  $F(1, 120) = 4.55$ ,  $p < .05$ ,  $\eta^2 = .04$ . When Libyan and Dutch children had the same pretest score, the former showed on average higher scores on the posttest (see Figure 1). As could be expected, the effect of pretest score level was also significant,  $F(2, 120) = 27.39$ ,  $p < .01$ ,  $\eta^2 = .31$ . In addition, the difference between the experimental and control group was significant,  $F(1, 120) = 12.80$ ,  $p < .01$ ,  $\eta^2 = .10$ . No interaction component was significant. A replication in a larger sample would be needed to determine the nature of this differential gain (e.g., differences in motivation or test-wiseness), assuming that the effect is reliable.

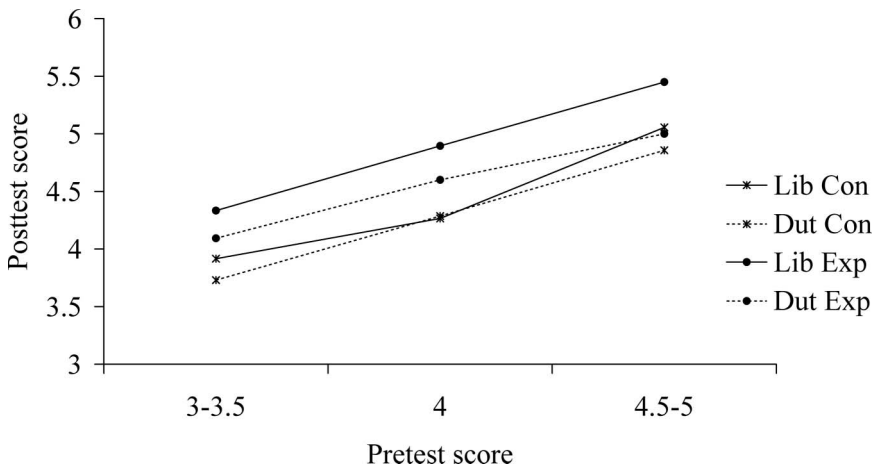


Figure 1. Relationship of pretest and posttest scores in both countries.

## Discussion

This study provided clear evidence that training in rehearsal can improve memory span in school children, both in Libya and The Netherlands. Effectiveness of rehearsal and positive effects of rehearsal training are probably features of memory functioning that are universal. There was also a main effect of country. Although modest in size, the effect indicates that Libyan children matched on pretest score level with Dutch children showed higher gains than their Dutch counterparts, both in the experimental and control groups. Two complementary explanations can be envisaged. Differential learning may be due to the fact that Dutch children were on average younger, and that training and retest effects are smaller for such a younger group. It is also possible (as argued before) that the Libyan group had less previous exposure to psychological testing and learned more from the first administration (cf. Van de Vijver et al., 1986).

## GENERAL DISCUSSION

The distinction between cross-culturally invariant structural features and variable control processes, introduced to cross-cultural psychology by Wagner (1981), served as a first approximation of where to expect cross-cultural similarities and differences. The distinction is not a dichotomy, but structural features and control processes are endpoints of a continuum of memory tasks with most tasks containing elements of both. Moving along the dimension in the direction of control processes, the performance on memory tasks become increasingly dependent on cultural mediation (Cole, 1996) and cultural loading (Helms-Lorenz, Van de Vijver, & Poortinga, 2003). Both of these concepts refer to the amount of acquired knowledge and experience needed to successfully accomplish the tasks. The first study was based on a specific model of working memory for auditory information, the phonological loop hypothesis (Baddeley, 1997). Differences in memory span between the Libyan and Dutch samples became small and non-significant, for digits as well as for other words, after correction for differences in pronunciation speed. Thus, in this study the cross-cultural differences in memory span could be fully explained in terms of some explicit cultural characteristic, namely word length in the two languages.

The second study (training of rehearsal strategy) involved more cultural mediation in that children were instructed to employ a rehearsal strategy. The data again suggested cross-cultural invariance at a basic level (i.e., memory performance increases with age and can be enhanced by training). This study allowed the interpretation of age-related patterns of cross-cultural score differences by comparing pretest and posttest scores in a rehearsal training and a control group. Rehearsal is a memorizing strategy

that tends to become more efficient with age over the middle years of primary school, but considerable cultural variation has been found, and it may not spontaneously be used in illiterate groups (Cole et al., 1971). All samples showed higher posttest scores, but the gains for the children in the experimental condition were larger than for those in the control group. Statistically significant but small interactions of culture with experimental condition (training vs. no training) and measurement occasion (pretest – posttest) could not be accounted for. Thus, in this study some minor effects of culture remained unexplained. This suggests that some relevant sources of cross-cultural score differences were not included in our design. It is unclear to what extent these unexplained differences are caused by confounding sample differences, such as motivation (the Libyan children seemed to be more motivated than the Dutch children) or learning during the first session (the Libyan children were less experienced with individual assessments and may have learned more from the first test administration).

From the perspective of education in the contemporary world, it is important for both individual and national development that children develop skills enhancing learning at school (Kagiticbasi, 1996). The findings of our studies have implications, notably for the Libyan educational system. First, explicit training had an effect on memory span in both countries. Second, mere practice (without training) had an effect, but explicit training increased this effect. Combining these two findings, we would suggest that encouragement of rehearsal strategies in classroom teaching could help children to make use of their mnemonic skills more frequently and extensively, both in Libya and The Netherlands. This finding is particularly relevant for Libya because of the emphasis on rote learning in the school curriculum. Although it is unclear to what extent the current training has long-term and broad-ranging effects, the universality of training effects makes it likely that good training programs are suitable for use across cultures.

*Manuscript received 9 May 2005*

*Revised manuscript accepted 15 March 2007*

*First published online 23 May 2007*

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